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THE INTER-RELATIONSHIP BETWEEN COMMODITY ENERGY PRICES AND STOCK MARKET VOLATILITY IN SAUDI-ARABIA

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ABSTRACT

Background and Purpose: The present study examines the inter-relationship that exists between commodity energy price as well as stock market volatility in Saudi-Arabia. The focus of the study is to test if changes in commodities energy prices (oil related) cause significant changes in the stock market volatility of Saudi Arabia.

Methodology: This study made use of a generalized autoregressive conditional heteroscedasticity model which has exogenous variables (GARCH-X), thus able to employ the commodity energy price inform of an exogenous so as to test the conditional variance of the Saudi-Arabia stock market return.

Findings: The findings from the estimated model provide evidence that only the ARCH and GARCH parameters are significant while the exogenous variables are insignificant. It is concluded that other factors affect the volatility of the Saudi-Arabia stock market, but not the commodity energy price.

Contributions: This study recommends that, policy makers, investors, and regulators should give emphasis on macro-economic variables and volatility interdependence with other correlated markets, especially during energy price shock that affected the volatility of Saudi-Arabia stock market.

Keywords: Energy price, GARCH-X, Saudi Arabia, stock market, volatility.

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1.0 INTRODUCTION

The uncertainty in the price of energy, particularly oil-related commodities, has led to the development of complex economic problems in both producers and consumers of the products. The nature of energy price has been an issue that has been addressed in many studies, such as Hamilton (2003) and Kilian (2009). The study of Hamilton (2009) explained the complex nature of energy price and argued that forecasting and managing energy price is very difficult due to the sudden shift in demand as well as supply, which normally occur due to the reduction in demand for petroleum product than supply. This has affected the development of many stock market volatility as well as macro-economic variables, where both are considered as the most affected variables. Studies such as Hamilton (1983), Federer (1996), Sadorsky (2001), and more recently Angelidis, Degiannakis, and Filis (2015) have established the link between energy price as well as the stock market with price correlation as the most concerned issue of discussion.

The price correlation is essential in the stock market as the most attracting variable to both policy makers and investors is the stock market volatility. This is due to the fact that volatility can change the expectation in the stock market with volatility persistence, where higher uncertainties tend to change investors decision as well as willingness to invest due to risk exposure. More so, the efficient and effective management of stock market volatility seek portfolio optimization as well as risk management. Based on this importance of determining stock market volatility, studies such as Malik and Ewing (2009) and Khalfaoui, Boutahar, and Boubaker (2015) among others looked into how commodity prices, especially oil affect stock markets' volatility. This is because the energy sector is marked by many peculiarities, for instance, inputs used in oil sector and the output produced are both capital intensive in the international markets. Specifically, the price of resources such as oil are very volatile coupled with exchange rate palaver.

The Kingdom of Saudi-Arabia is among the global energy leaders as it is the largest producer of oil around the globe. This is synonymous to the fact that Saudi-Arabia heavily relies on oil export, hence, movement or fluctuation in oil price is very crucial in the country's economic policy design. Oil price shock in the 1980s, 1990s and the 2000s severely affected its macroeconomic performance. Like the economy, the stock market highly depends of capital

tied up in the energy industry and are determined by commodity prices, in which volatility affects the entire stock market. It is also imperative to mention that stock market volatility may depend on the importance of some macroeconomics situations, information and price of some important commodities of a country.

Figures below are graphs of selected volatility variables of this study. From the figures, it can be seen that the behaviors of the selected variables are different. The plots of Tadawul All Share Index (TASI) and Saudi Petrochemical Price (SPP) show that the data revolve around the mean, and the preliminary data show some sign of volatility cluster. The price is almost similar to that of TASI and SPP while that of SEP shows upward trending. The plots of all the data set exhibit features of economic and financial variables.

Figures below show the visual pattern of return series of Saudi stock market index TASI, Saudi petrochemicals price index SPP and the visual series pattern of Saudi gas price (SGP), Saudi oil price (GOP) and short interest rate (SIR) in Saudi Arabia.

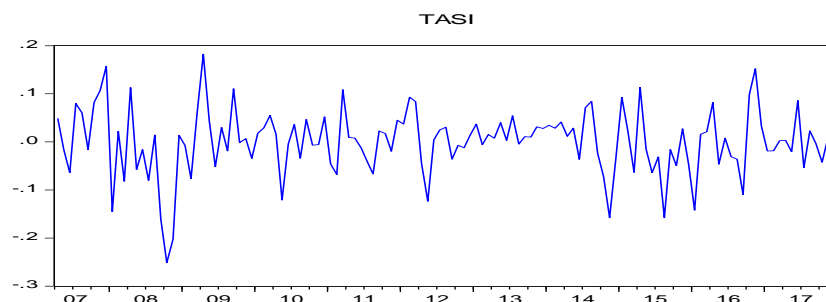


Figure 1: A Plot of Saudi Stock Market Index (TASI)

Figure 1 is the plot volatility of TASI index. From the figure, there is evidence of sharp volatility during the period 2008–2009, which co-incident with the global financial crisis. In addition, the figure shows volatility during the period of 2014–2016 due to the sharp decrease in global oil price.

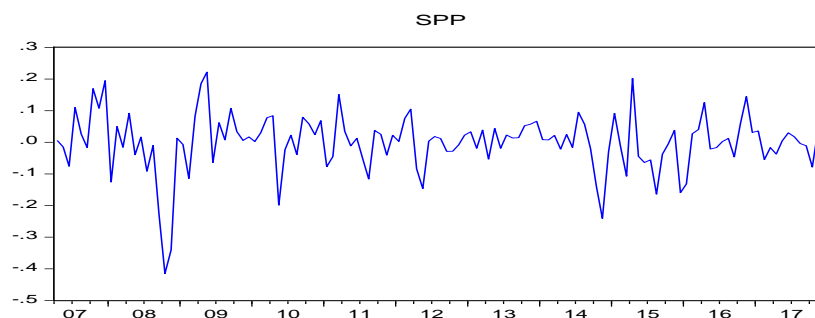


Figure 2: A plot of Saudi Petrochemicals Price Index (SPP)

Figure 2 is a plot of the volatility of the SPP index. Like that of TASI, the figure shows evidence of volatility clustering with intense volatility during the period of 2008–2009 and 2014 and 2015, which coincident with the global oil price and fall of global oil price.

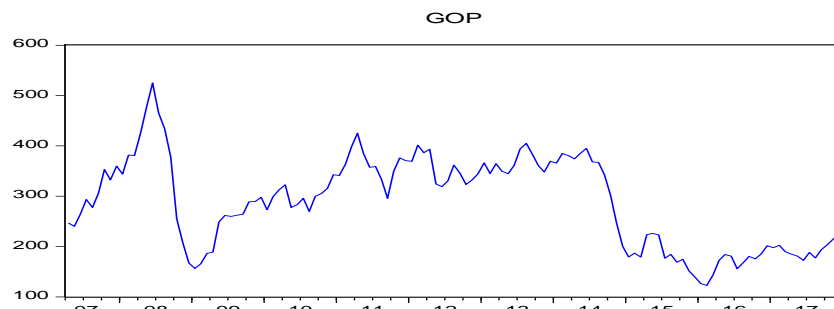


Figure 3: A plot of Global Oil Price (GOP)

Figure 3 depicts a plot of the volatility of GOP data. The data is not upward trending, but there is evidence of volatility clustering. The picture also shows a fall in both in 2008 and 2015, which coincident with global financial crisis and global oil price.

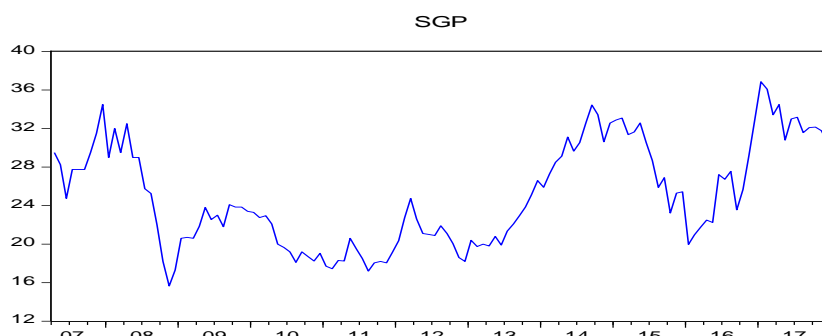


Figure 4: A plot of Saudi Gas Price (SGP)

Figure 4 shows a plot of the volatility of SGP. The figure shows evidence of volatility clustering with a sharp fall during the periods of the global oil price and decrease in global oil price.

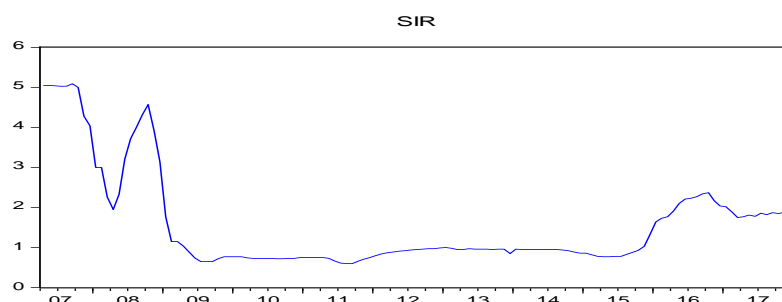


Figure 5: A plot of Short Interest Rate (SIR)

Figure 5 is a plot of the volatility of SIR. The graph indicates that after the year 2009, there are significant changes.

Available literature shows that the rise or fall in the oil and gas price will no doubt affects the stocks of the companies related to the oil and gas business market volatility. Awerbuch and Berger (2003) argued that beginning from 1980s, the oil price volatility despite energy options, is more detrimental to the stock market as well as the economy at large. Therefore, this paper examines if changes in commodities energy prices (oil related) cause significant changes in the stock market volatility of Saudi Arabia. As such, through the empirical approach employed in the present study, the issue of the relationship that exists between commodity energy prices as well as stock market volatility in Saudi-Arabia are addressed. The paper employs a generalized autoregressive conditional heteroskedasticity model with exogenous variables (GARCH-X). This implies that the Saudi-Arabia market is run by more of external factors than internal factors. This represents that the Saudi market is more of export to foreign countries than importation.

Previous studies that were carried out on the relationship between oil price in relation to stock market return by several scholars are Sadorsky (2001), Abhyankar, Xu, and Wang (2013), and many others. Their studies discovered that oil price shock caused by supply possess a higher negative impact on the stock market than the ones which are caused by the demand of oil price shock (Cunado & Gracia, 2014). Most studies carried out on the impact of oil price in the developed countries stock markets, which in most cases oil importing nations have discovered that a negative relationship exists between oil price as well as stock market (Miller & Rati, 2009; Driesprong, Jacobsen, & Benjiman, 2008; Basher, Haug, & Sadorsky, 2012). According to some other researches, there exists a positive relationship between oil price in relation to stock market among the oil-exporting nations (Lescaroux & Mignon, 2008; Mohanty, Nandha, Turkistani, & Alaitani, 2011; Hammoudeh & Choi, 2006; Fayyad & Daly, 2011). According to Samih and Loucine (2013), oil price impact on stock log returns has been statistically significant for both nations (Saudi Arabia and Kuwait). However, there has been double impact coefficient of oil price for the Saudi market, which is put at 0.1779 and seen to be a second contrast. Whereas the third contrast is found in the estimates of the model equation (2). With regards to the Kuwaiti market, only negative oil shocks impinge significantly on Kuwaiti stock log returns, while, in the Saudi market, both positive and negative changes in oil prices are statistically significant. The impact of negative oil price shocks on stock returns is again double for the Saudi market. It is obvious and apparent that volatility is a vital issue in stock market attractiveness to potential investors. Markowitz (1952) framework of (μ, σ) rule

has explicitly explained that both expected return and undesired volatility matters in portfolio construction. Sadorsky (2003) argued that negative macroeconomic affects resource price volatility that even non-energy stocks seem to be driven by oil price volatility. This leaves a huge gap that the energy resource price and stock market volatility relationship has been ignored. These dynamics have not been observed together with exogenous energy price movements and oil price volatilities. Therefore, the objective of this paper is to determine if commodity energy price contributes to the stock market volatility of Saudi-Arabia. This study employs a new set of variables in the GARCH-X model, which has not been used in other studies.

2.0 LITERATURE REVIEW

The study by Hamilton (1983) is among the pioneer and forefront studies on the relationship of oil price changes on the economy. Subsequent studies such as Hamao (1988), Ferson and Harvey (1995), Kaneko and Lee (1995), Basher and Sadorsky (2006), Filis and Chatziantoniou (2014) among many other studies, concentrated firmly on commodity energy price-stock market relationship. However, the studies have not yet reached consensus with some finding suggesting positive, negative, and no relationship.

The inconsistency in the literature leads most studies to go deep and concentrate on the relationship between commodity energy price and energy sector returns. For instance, El-Sharif, Brown, Burton, Nixon, and Russell (2005), Narayan and Sharma (2011), and Scholtens and Yurtsever (2012) found conflicting results with some showing negative relationships. In addition, Bashir and Sadorsky (2006) concluded in their study that oil price influences the stock market return, which depends on the country that is being researched; whether the country is an importer or an exporter. The same conclusion was reached later by Ogundipe, Ojeaga, and Ogundipe (2014) when they delved into the oil price's effects towards the volatility of the Nigeria stock market. In another study on the same subject, Chang, McAleer, and Tansuchat (2009) also came to the same conclusion, that is, the effects of oil on the stock market depends on whether the country is an exporter or otherwise. That study added that if a large number of the firms are consumers of oil, thus, oil price and stock market volatility will be negatively correlated.

However, just like the stock market volatility, it is difficult to predict the reactions of stocks to oil price (Ross, 2017). Studies conducted by Bashir and Sadorsky (2006), Bjornland (2009), and Arouri and Rault (2011) have found positive relationship in stock market returns and increase in oil price in the oil exporting countries. On the other hand, researchers like

Hooker (1996), Hamilton (2005), and Chinn, LeBlanc, and Coibion (2005) suggested that opposite result is found in the increase of the oil price because a hike in oil price will lead to major decrease in the stock market returns. In fact, several researchers like Kilian (2009), Balaz and Londarev (2006), Cunado and Gracia (2014), as well as Cologni and Manera (2008), have all revealed in their study that in some selected emerging and developed countries that import oil, there exists a negative relationship between economic activities in regard to oil prices. More recently, Kang, Ratti, and Vespignani (2017) analysed how oil price shock affects the oil and gas return in selected companies in the United States (US). The study selected Exxon mobile, BP, Royal Dutch Shell, and Chevron, and found that negative energy supply shock triggers negative returns in the oil and gas sector returns. Moreover, the study found that at individual company level, the result is different that both positive and negative energy supply shock trigger positive responses to firm-level stock returns. This indicates that the relationship is not company-specific but sector or industry-specific. Furthermore, that study analysed the effect of commodity energy price on upstream, down-stream and middle stream companies (Valero Energy Corporation, Conoco Philips and Trans-Canada Corporation) and found that the responses of the companies are similar to that of the major oil companies that are previously explained.

Available studies carried out by Apergis and Miller (2009), Kilian (2009), and Jung and Park (2011) decomposed their study based on net oil producers as well as consumers' nations respectively. The study by Jung and Park (2011) specifically carried out analysis on the commodity energy price in regard to stock market in the country of Norway as well as Korea, where the study was able to prove that there is a more prevalent impact on the shock of the oil importing nations. Similarly, Wang, Wu, and Yang (2013) investigated 16 stock markets of nine oil-importing and seven oil-exporting countries and found that none of the stock markets responded to supply-side oil price shock. However, the study did not find evidence of positive oil response from oil importing stock markets to positive aggregate demand shocks.

Another plausible explanation in the literature is how changes in commodity energy price affect stock market volatility. Ross (1989) opined that the volatility of the stock market could come from the volatility of some assets or important variables in an economy. Huang, Masulis, and Stoll (1996) justified that oil price movement and stock market volatility could be realized through their volatilities. Further studies in this regard are that of Malik and Ewing (2009), Vo (2011), and Arouri, Jouini, and Nguyen (2011). However, Boldanov, Degiannakis, and Filis (2016) as well as Maghyreh, Awartani, and Bouri (2016) recently found evidence that the volatility of the oil price is the major factor transmitting volatility to stock markets.

This supports the findings of Du and He (2015) that significant risk spillovers between oil and stock markets and negative spillovers flowed from oil volatility to stock market volatility. Also, of recent, Shaeri and Katircioglu (2018) employed Carrion-i-Silvestre, Kim, and Perron unit root tests and Maki cointegration tests, allowing for multiple breaks. The study provided empirical evidence of long-run equilibrium relationships between these stock indices, crude oil prices, short-term interest rates, and the S&P 500 in the US. That study results portrayed that stock prices of oil companies are positively affected by crude oil prices to a greater degree than that of technology and transportation stocks.

In terms of the methodology, previous studies employed either Time-Varying Parameter VAR model of Primiceri (2005), multivariate GARCH models (such as the Dynamic Conditional Correlation) of Engle (2002) or Baba-Engle-Kraft and Kroner (BEKK) model by Baba, Engle, Kraft, and Kroner (1991) and Engle and Kroner (1995). In this regard, Kilian (2009) used Structural Vector Autoregressive (SVAR) model, which allows the identification of the three oil price shocks, where that study concluded that the effect of oil price to stock markets depends on the type of shock. On the other hand, studies such as Bhar and Nicolova (2010) and Degiannakis, Filis, and Floros (2013), among others, employed the multivariate generalized autoregressive conditional heteroskedasticity GARCH (MGARCH) models, and concluded that relationship between commodity energy price and stock market is time-varying, which is driven by economics or geographical development such as the Arab spring. Furthermore, Arouri and Nguyen (2010), Elyasiani, Mansur, and Odusami (2011) and Broadstock, Wang, and Zhang (2014) employed the univariate GARCH model in their studies while Efimova and Serletis (2014) employed a univariate GARCH-In mean model and captured the effect of the commodity energy price in both the mean and the variance equation. Ljungqvist and Palmqvist (2014) used exogenous variables which enabled them to predict the returns in the European Union emission trading system (EU-ETS). In this study, a variant of univariate GARCH model with exogenous variable (GARCH-X) is employed which will allows the usage of exogenous variables and captures their impact on the conditional variance.

Compared with other models, it is envisaged in the present study that the GARCH-X process substantially exhibits different characteristics, in particular during the time the covariate is persistent in memory. The covariate is allowed to be stationary of long as well as short memory, and integrated or nonstationary of long memory. As such, here the study models the covariate as a fractionally integrated process that has a wide range of order of integration for it to be able to represent different kind of time series of the covariates employed in the model of the GARCH-X. This no doubt seems desirable, based on the fact that each of the

employed covariate in the GARCH-X models presents various kind of degree of persistence. On the other hand, there exist nonstationary of some of the time series covariates, which can therefore be modeled as unit root processes, while there is a clear rejection of the time series of other covariates towards the unit root hypothesis. More so, even if there is a rejection of the unit root hypothesis for these variables, yet the degree of persistence is mostly high in the economic variables that are employed in the GARCH-X models. Moreover, it is well-known that the time series of realized measures are also persistent. Taking as an instance, Andersen, Bollerslev, Diebold, and Labys (2003), Hol (2003), as well as Andersen, Bollerslev, and Diebold (2009) stated the evidence of long memory in the time series of realized measures.

Conversely, the employed covariates in the GARCH-X models are mostly economic variables, but of recent, there are various realized measures of volatility constructed from high-frequency data which have all been adopted along the rapid development in the field of realized volatility. The multiplicative error model (MEM) by Engle (2002) first used the realized variance as the covariate in the framework of the GARCH-X model. Barndor-Nielsen and Shephard (2002) included both the realized variance and the bipower variation (Engle & Gallo, 2006; Shephard & Sheppard, 2010; Hansen, Huang, and Shek, 2010). In particular, HEAVY model by Shephard and Sheppard (2010) and the Realized GARCH model by Hansen et al. (2010) specify the conditional variance as the GARCH-X model with the restriction of $\omega = 0$ in (2) below.

Over the years, findings in available literature shows that exogenous variables' influence, like economic indicators on correlations has no doubt been largely ignored. However, there are enormous potentials associated with economic variables that simultaneously influence several time series, which invariably driving conditional correlations. In time of adopting regression analysis, few studies already demonstrated that economic conditions are capable of altering conditional correlations (Quinn & Voth, 2008; Andersson, Krylova, & Vahamäa, 2008). More so, it has also been established that economic variables are capable to describe the conditional mean (Aït-Sahalia & Brandt, 2001; Guidolin & Timmermann, 2008) as well as the conditional volatility (Engle, Ghysels, & Sohn, 2009; Engle & Rangel, 2008; Whitelaw, 1994) of asset returns.

Conversely, various empirical studies might have benefited from the use of correlation models, paving more rooms for the influence of exogenous variables. Taking as an instance, an ongoing debate has been going on with regards to the existence of contagion among stock market returns in relation to its potential triggers. As defined in many studies, contagion is a change in conditional correlations (Forbes & Rigobon, 2002; King & Wadhwani, 1990;

Corsetti, Pericoli, & Sbracia, 2005), thus the correlation models with exogenous variables could be used to determine contagion as well as its causes. Another area of study has been channeled towards the benefits of international diversification (Longin & Solnik, 1995, 2001; Solnik, Boucrelle, & Fur, 1996; Goetzmann, Li, & Rouwenhorst, 2008) and asset-allocation (Guidolin & Timmermann, 2008; d'Addona & Kind, 2006; Ang & Bekaert, 2002). Based on this, it is interesting to see why the existing correlations between markets change. In the same vein, there are fewer researches which have focused on the convergence in the Eurozone (Berben & Jansen, 2005) and searched for drivers that describe the increasing correlations among Eurozone markets.

3.0 METHODOLOGY

The objective of this paper is to determine whether commodity energy prices have impact on the volatility of Saudi-Arabia stock market. Therefore, this study tests if changes in commodities energy prices (oil related) cause significant changes in the Saudi stock market volatility. Since the development of the Autoregressive Conditional Heteroskedasticity (ARCH) model by Engle (1982) and the extension to generalized ARCH (GARCH) model by Bollerslev (1986), the ARCH family model has been widely used in determining volatility. The model witnesses various developments over the period, such as Exponential GARCH (EGARCH) of Nelson (1991), the GJR-GARCH of Glosten, Jagannathan, and Runkle (1993), the family GARCH (FGARCH) models of Hentschel (1995), Baillie, Bollerslev, and Mikkelsen (1996), fractional integrated GARCH (FIEGARCH) the threshold GARCH of Zakoïan (1992), and the multivariate GARCH by Engle and Kroner (1995), amongst others.

The present study employs a variant of the GARCH model which accommodates exogenous variables (GARCH-X) to meet the objective of the study. The development of the model started from the work of Sharma, Mougoue, and Kamath (1996), and later Engle and Patton (2001) introduced interest rate levels in many GARCH models. Later, Ashok, Subhadeep, Soham, and Rahul (2011) improved the GARCH model by introducing stock's volume as a proxy for information flow and company-specific announcements in the volatility equation. The model further found a place in the work of Han and Kristensen (2012) and Han and Park (2012). Nana, Korn, and Erlwein-Sayer (2013) explained in detail the theoretical properties and application of the model that include ergodicity, geo-metric ergodicity, the existence of moments of the extended-GARCH, consistence and asymptotic normality of likelihood estimators. The GARCH-X model is specified in the below equations.

Starting with GARCH (p,q) which is defined as Equation (1)

$$\epsilon_t = z_t \sigma_t \quad z_t \sim \text{IID} (0,1) \quad (1)$$

Here, z_t is the innovation term and the conditional variance (volatility of the Saudi stock market) is given in Equation (2)

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^p \beta_i \sigma_{t-i}^2 + \sum_{j=1}^q \alpha_j \epsilon_{t-j}^2 \quad (2)$$

Where, σ_t^2 is a non-negative and weak stationary, thus making the required conditions to be;

$$\alpha_0 > 0$$

$$\beta_i > 0 \quad i = 1, 2 \dots p$$

$$\alpha_j > 0 \quad j = 1, 2 \dots q$$

$$\sum_{i=1}^p \beta_i + \sum_{j=1}^q \alpha_j < 1 \quad (3)$$

Following the above GARCH model, the GARCH-X model is expressed in Equation (4)

$$\sigma_t^2 = \alpha_0 + \beta_1 \sigma_{t-1}^2 + \alpha_1 \epsilon_{t-1}^2 + x \quad (4)$$

Where:

σ_t^2 is its variance conditional on the information available at time t-1,

ϵ_{t-1}^2 is the covariate,

x is the exogenous variables in which the conditional variance σ_t^2 is determined by ARCH (β), GARCH (α), and (x) the exogenous variables. The exogenous variables are Saudi petroleum price, global oil price, Saudi gas price, and Saudi interest rate.

4.0 ANALYSIS AND DISCUSSION

To meet the objective of the study, the monthly time series data of five variables, which are Saudi stock market return (TASI), Saudi petroleum price (SPP), global oil price (GOP), Saudi gas price (SGP), and Saudi interest rate (SIR) for the period of April 2007 to December 2017 are employed. Scholes and Williams (1977) argued that monthly data has some advantages over daily or weekly data because low trading data may induce errors in variables problems. All the data were retrieved from data stream international, which were log-transformed except for TASI, which was converted from the market index.

The study examines whether commodity energy price volatility, Saudi petrochemicals price index SPP, Global oil price GOP, Saudi gas price SGP, and short-term interest rate SIR affect the conditional variance of the Saudi-Arabia stock market return (TASI).

Table 1 reports the result of the descriptive statistics of the variables in this study. It is evidenced from the result that TASI has a positive mean of 0.000, which corresponds with a standard deviation of 0.068 that measures the risk of investing in the market. To measure the normality of data, this study employs skewness, kurtosis and Jarque-Bera statistics. The result shows that TASI variable is negatively skewed with a value of -0.561 and indicates that the skewness is non zero; hence, the variable is asymmetric in nature. The kurtosis of TASI is 4.521 which indicates the distribution of the series to be leptokurtic since it is greater than 3. The Jarque-Bera statistics do the overall normality analysis; the result for the dependent variables indicates that the distribution is not normal. However, it is widely agreed that financial variables such as stock return are not normal. The result of the exogenous variables is almost similar to that of the dependent variable. It can be observed that all the exogenous variables have positive mean, and SPP is one of the less volatile of the variables with a standard deviation of 0.092. Furthermore, the Jarque-Bera test indicates that the distributions of one of the exogenous variables (GOP) are normally distributed. TASI, SPP, SGP and SIR were significant at 1% level of probability.

Table 1: Descriptive statistics

Variables	Min	Mean	Max	Std Deviation	Skewness	Kurtosis
Jarque-Bera						
TASI	-0.2513	0.0001	0.1823	0.0689	-0.5619	4.5219
SPP	-0.4150	0.0008	0.2223	0.0922	-1.1009	6.9365
GOP	122.780	288.5095	524.850	89.1394	-0.0102	2.0319
SGP	15.6500	25.0110	36.8600	5.3319	0.3100	1.8675
SIR	-0.5108	0.2334	1.6272	0.6123	0.9468	2.6900

(*) indicates significance at 1 percent

ARCH family models are the appropriate framework to study the problem of volatility clustering, in which large changes tend to follow large changes, and small changes tend to follow small changes. The pre-necessary condition for modelling the ARCH family model is the determination of the ARCH effect in the data set for the study. To satisfy this condition, Engle (1982) proposed the Lagrange Multiplier (LM) test, in order to test the existence of ARCH behavior based on the regression. The result is presented in Table 2. From the result, the null hypothesis of no ARCH effect for all the variables is rejected. The detection of the ARCH effect in the data series is actually a test of serial independence applied to the serially uncorrelated fitting the model. This guarantees the application of the ARCH family models.

Table 2: ARCH test

Variables	ARCH Effect
TASI	17.060*
SPP	39.561*
GOP	7.951*
SGP	2.945**
SIR	15.280*

*and** indicates statistical significance at 1 and 5 percent respectively

Table 3 presents the result of the estimated GARCH-X of the study. The result is presented as the mean-variance of the model. The parameter C , which represents the mean Equation is statistically significant and indicates a positive mean return on investment in the market despite the fluctuations. The parameter ω in the variance equation is also statistically significant at 10%; however, the parameter has low value, which indicates the stability of the long-term mean of the variance equation of the model. The ARCH (α) and GARCH (β) parameters are both statistically significant at 1 percent. This notifies the effect of previous information on the current information of the TASI stock market volatility and the past conditional variance affects the present's conditional variance in the TASI.

Table 3: Result of the GARCH(X) model

Mean Equation		Coefficient	
Probability			
C	0.0145		0.004*
Variance Equation			
ω	0.000		0.094***
β	0.458		0.008*
α	0.517		0.000*
SPP	-9.570		0.421
GOP	2.820		0.875
SGP	0.000		0.645
SIR	-0.000		0.856
F-statistic	0.071417	Prob. F (1,125)	0.7897
Obs*R-squared	0.072518	Prob. Chi-Square (1)	0.7877
Jarque-Bera	2.8995	Prob	0.2346

*and*** indicates statistical significance at 1 and 10 percent respectively.

Another interpretation of the result is that the significance of the ARCH and GARCH parameter indicates that a 1% increase in shocks affects the conditional variance to increase by 0.458%. And a 1% increase in one period lagged conditional variance affects the conditional variance to increase by 0.517%. The sum of the coefficients of the ARCH and GARCH satisfies the theoretical postulation and indicates high volatility persistence in the market. In other words, past shocks and variances have longer effects on the future conditional variance. It can also be described as the degree of persistence in the autocorrelation of squared returns, and in turn, it controls the intensity of volatility clustering.

The coefficient of the exogenous variables SPP, GOP, SGP, and SIR are all statistically insignificant. The insignificance of the variables portrays that the variable does not contribute to the volatility of the Saudi-Arabia stock exchange market. This proves that changes in commodities energy prices (oil related) do not cause significant changes in the Saudi stock market volatility. This result is supported by previous research from Jung and Park (2011) but

however is found in contrast with studies such as Ljungqvist and Palmqvist (2014), and Maghyereh et al. (2016).

The reliability of the inferences made from the estimated GARCH-X model depends upon the model passing the diagnostic checks. In the univariate GARCH models, the most widely and accepted diagnostic checks are autocorrelation, heteroscedasticity, and normality test. This study employs the Breusch–Godfrey test for autocorrelation and heteroscedasticity, which fails to reject the null hypothesis of no autocorrelation from lag 1–36. Similarly, there is no evidence of heteroscedasticity which concludes that the model is homoscedastic. Finally, the Jarque-Bera statistics indicate that the residuals of the model are normally distributed. The model has passed all the diagnostic checks whereby inference from the estimated model are statistically reliable.

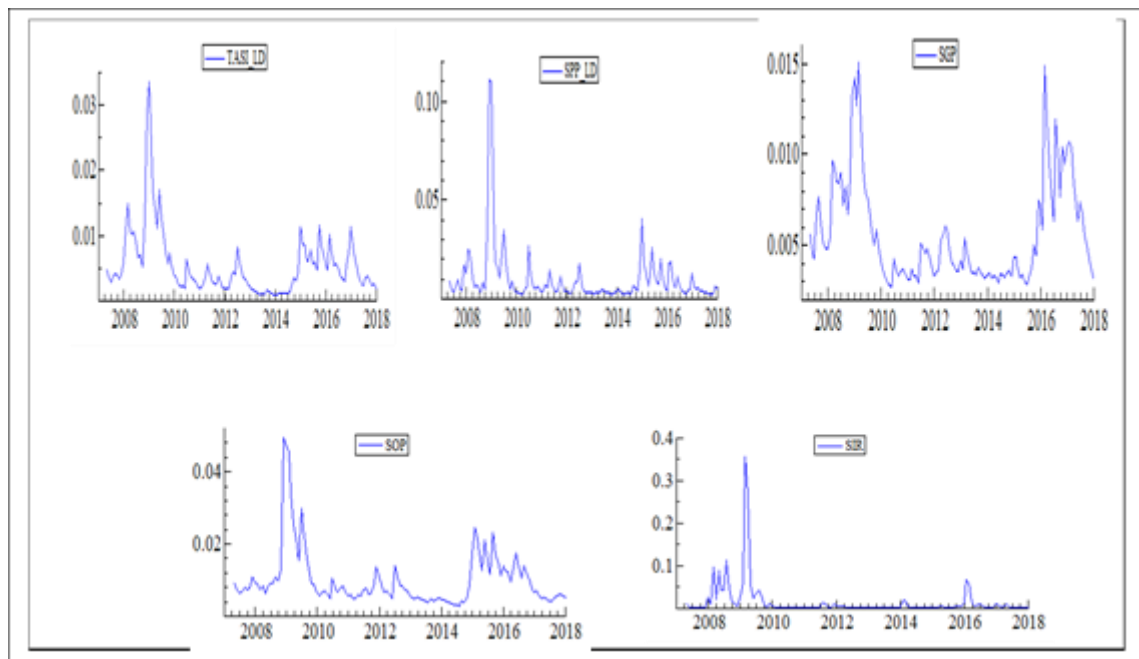


Figure 5: Volatility profile of Stock Market Index TASI, SPP, SGP, SOP and SIR

Figure 5 above is the plot of GARCH volatility portfolio of Saudi stock market index TASI, Saudi petrochemicals price index SPP, Saudi gas prices, Saudi oil prices, and short interest rate SIR. From the figure, there is evidence of volatility clustering where the periods of high volatility are being followed by the periods of high volatility, while on the other hand the periods of low volatility are also been followed by the periods of low volatility. It also shows high volatility during the financial crisis in 2008–2009, and the global oil prices increase in 2015–2016.

5.0 CONCLUSION

This paper examined the relationship between commodity energy price and stock market volatility in Saudi-Arabia. Besides TASI, the study focused on three-commodity energy price: SPP, SGP and GOP and also included SIR in the estimations and analysis. The findings from the estimated GARCH-X model provided evidence of significant ARCH and GARCH parameter. Furthermore, the result did not provide empirical evidence that the exogenous variables have impact on the conditional variance (volatility) of the Saudi-Arabia stock exchange market. This indicates that the volatility of oil related energy price has no dynamic relationship in the Saudi stock market volatility. Hence, changes in commodities energy prices (oil related) do not cause significant changes in the Saudi stock market volatility. To conclude, it is important to stress that the analysis above has shown that the ARCH and GARCH parameter are the main factors that affect stock market volatility in Saudi-Arabia, not the commodity energy price. These findings indicate that the insignificance of the explanatory variables is because they are long-run determinants of the stock market volatility and not short-run. As such, it cannot be properly captured by the method employed. It is recommended for further study to employ other methods that could be used to determine the significance of the exogenous variables.

Therefore, the policy implication and recommendations from the analysis above are that policy makers, investors and regulators should give emphasis on how other macro-economic variables and volatility interdependence with other correlated markets especially during energy price shock that affected the volatility of Saudi-Arabia stock market.

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